ABSTRACT

R. LANE TIPPENS. Effect of global workplace smoking prohibition on cessation rates and cigarette consumption: a prospective study.

Assessing the effect campus-wide smoking restriction may have on the aggregate quit rate and cigarette consumption in a population of smoking employees, a prospective cohort study was undertaken at two pharmaceutical company campuses, 1989 through 1995, using questionnaires. The relative success of various cessation programs were also determined using quit rates as outcome measurements.

Results were as follows: The overall six year quit rate in this cohort was 28.6% (65/227), and tobacco consumption among active smokers was reduced 21.7% during the study interval. No single formal cessation program was found to be superior, and in fact all of the programs fell short of the results seen in the nonparticipant subgroup. Characteristics associated with improved outcome were higher level of education; less than a pack per day of cigarettes, maximum use; spousal encouragement to quit; and negative answer to question *does co-worker smoke*.

Although the significance of the study is obscured by the dearth of comparable data in existing literature, a global smoking prohibition in the workplace may be an effective adjunct for improving quit rates or for reducing cigarette consumption among smoking employees. Consistent with other

studies, we found reductions in cigarette consumption after a smoking control policy, as well as disappointing outcomes associated with structured cessation programs.

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INTRODUCTION

A voluminous amount of research has been undertaken in the past decade evaluating the efficacy of various approaches to smoking cessation. The bulk of smoking cessation literature has addressed the relative success rates of formal treatment programs. Data from the 1986 Adult Use of Tobacco Survey (Centers for Disease Control) was analyzed to classify cessation techniques and results. This largely community based study concluded that smokers who seek help tend to be heavier users, and that those who attempt to quit on their own are more successful. The author questioned the cost-effectiveness of many smoking cessation programs.[1]

Nicotine Replacement Therapy (NRT) has been the object of much recent scrutiny. In one study nicotine gum was found to most efficacious in the highly dependent individual.[2] A meta-analysis revealed NRT in general to be effective,[3] and other recent studies suggest some predictors for NRT success in an individual user.[4,5]

In spite of promising results from NRT studies, a review by Shiffman argued that, insofar as a community approach to smoking cessation is concerned, there have been few innovations in the past decade, and that average outcomes have not improved.[6] The recently reported experience by the NCI funded COMMIT (Community Intervention Trial for Smoking Cessation) study would support that conclusion.[7,8] If indeed, the maximal potential of outcome has been realized for community- and clinic-based smoking cessation efforts, perhaps we should mine deeper for the ultimate potential in worksite anti-smoking programs. There may be a far greater return on efforts in this direction.

The Work Place

While initiatives outside of the workplace to increase quit rates have shown great limitations, there is evidence that work site programs have appeared to be more effective than clinic- and community-based smoking cessation programs, in terms of maintenance of abstinence over a period of time.[9]

The business community has financial as well as altruistic incentives to eliminate work place smoking. The increased health-care costs incurred by smokers are

generally known, but there are also other less obvious liabilities. Costs due to fire loss, increased absenteeism, and higher life insurance premiums should be factored in, as well as diminished productivity due to time lost to smoking rituals. Some research suggests that, on the average, smokers have twice the accident rate of nonsmokers, leading to a differential in Worker's Compensation costs between the two populations.[10]

Foremost, there are the obvious health consequences of active smoking, and the more controversial effects from passive smoking for non-smoking workers in an area where smoking has not been disallowed.[11,12] The Surgeon General of the United States has stated that "cigarette smoking is the single most important preventable environmental factor contributing to illness, disability and death in the United States".[13] Addressing the workplace, the Surgeon General concluded that "for the majority of American workers, cigarette smoking represents a greater cause of death and disability than their workplace environment".[14] A number of federal agencies and independent researchers have suggested that environmental tobacco smoke may be linked to cancer,[15,16,17] and in 1992, the EPA concluded that environmental tobacco smoke should be classified as a group A carcinogen.[18] Furthermore, the American Heart Association, in a 1992 position paper, considers passive

smoking a major preventable cause of cardiovascular disease and death.[19]

Finally, as cigarette use is most prevalent among the middle-age population subset,[20] and given that this group has the highest employment rate, it follows that aggressive workplace cessation strategies may maximally benefit a particularly exposed target population.

A smoke-free work place is rapidly becoming perceived by the working population as an expected entitlement, and an activist *nonsmokers' rights movement* has promoted this expectation. Failure to provide employees with a smoke-free environment has provided the grounds for civil tort in a few states. Even among smokers, employee attitudes are generally supportive of smoking controls wherever these have been implemented.[21,22]

None of these points have been lost on Management. In New Jersey, where there are statutory smoking restrictions for work sites with 50 or more employees, a survey revealed that small businesses which choose to implement restrictions in the absence of legal mandate, tended to enact prohibitions more restrictive than that which had been mandated of the larger companies.[23] Census data from North Carolina from 1993 indicates that over 31% of employees report some form of worksite smoking restriction. This figure, however, is far short of the stated U.S. D.H.H.S.

goal of 75% of the proportion of worksites with a formal smoking restriction by the year 2000.[24]

The Smoking Habit

Like any habitual activity, the smoking habit may be amenable in a number of stages. Logically, there are four areas of behavior where the smoking habit may be impacted: *initiation of the habit*, *reduction of tobacco use*, *smoking cessation*, and finally *combating recidivism*. In attacking the smoking habit in a population, workplace smoking controls may be expected to have desired effects on each of these steps. Since one third of a worker's waking hours are spent at his place of employment, a workplace free from these negative cues may represent an environment more conducive to abstinence. In 1989 the *American Journal of Health Promotion* revised it's definition of health promotion to include the importance of environmental factors in the facilitation of good health habits. Addressing lifestyle change, the authors conclude that "supportive environments will probably have the greatest impact in producing lasting changes".[25] The ideal goal would be to engineer changes in the employee's social and physical milieu that would be supportive of healthier lifestyles. *Worksite culture* clearly should have a significant effect on worker attitude and behavior, and smoking restriction as a symbol of

organizational commitment should not be underestimated as an effector on employee health habits.

The workplace may be an important setting for the uptake of the smoking habit. In Australia 34 % of smokers have reported initiating the smoking habit while on the job.[26] It is obvious that a workplace where the smoking ritual is absent is a less likely place for *initiation* of the smoking habit. In this regard the worksite culture again exerts a powerful influence.

Previous studies support the notion that workplace smoking restrictions lead to *reduction of tobacco use* in smokers.[27,28,29,30,31,32,33] This effect is most pronounced in heavy smokers, and so the policy benefits that population most in need of help. Workplace restrictions may provide a means by which these individuals can reduce their consumption to less harmful levels.

The decision to quit smoking has been conceptualized as a motivational readiness, and, with each worker, this may represent a long-term dynamic process. Individuals may be characterized on a dimension of readiness to quit ranging from not at all ready (precontemplation), to successfully having quit and maintaining abstinence (maintenance).[34] It may be assumed that over time, smokers move through these stages of change, and so time itself, would be an important variable to consider. Smoking *recidivism* may represent an interruption in this motivational continuum. A strong

predictor of relapse following cessation is the smoking habits of family and friends.[35] It follows that habitual behavior is subject to modification by the alteration of environmental stimuli. Also, intervention attempts may, in their aggregate, have significant impact. This would support the argument that a long-term, consistent workplace smoking cessation strategy including smoking prohibition, may pay extended dividends, namely better long-term quit rates.

Workplace smoking policies

Corporate smoking policies include a wide spectrum of strategies which range from removal of cigarette machines from the premises, to campus wide prohibition. Program- or therapist- assisted methods to stop smoking are frequently offered. The greatest problem with such programs is that so few smokers choose to participate. Participation rates may range as low as 10%, and employee interest generally is highest immediately before the initiation of a new policy, with dramatic fall-off thereafter.[36] This contrasts with the estimate, in 1987, that two-thirds of all smokers report at least one serious lifetime quit attempt, and one-third report having tried to quit during the prior twelve months.[20] In fact, in 1986, only 5.6% of successful quitters used assisted methods to stop their habit.[37] There is little reason to suggest these numbers have changed. If assisted

methods indeed have minimal impact, and most smokers quit "on their own", then by default, workplace smoking controls may have a major impact on employee quit rate.

The Problem with Definition

As of 1988, a review of published worksite cessation programs revealed that only a few of the papers by that date had focused on a smoke free environment as a study variable.[38] More recently, however, there have been a number of studies evaluating quit rates or smoking prevalence as outcome of interest after a period of workplace smoking controls. These efforts have yielded varied conclusions, and the body of literature on the subject, as it exists today, is not easily interpreted.

The problem may lie in inconsistency of definitions. Outcome of interest, abstinence, lacks a standardized denotation. Others have noted that a great problem lies in the definition of *smoking control* or *smoking restriction*.[39] Smoking policies vary so greatly in substance, as well as in implementation, that it is difficult to evaluate *smoking restriction* as a unitary intervention. In a recent meta-analysis of quit rates, it was found that although 75.6% of work sites had formal policies restricting smoking, only 5% of the studies reviewed reported specific information on those policies.[40] When disclosed, the smoking controls were often compromised by allowance of designated smoking areas.

This was the dominant corporate policy design found in the papers reviewed. Many of the studies reviewed fail to specifically define *smoking restriction*. One would be behooved to make a default assumption that a majority of these policies, at best allowed on-site parking-lot smoking, and at worst were more permissive and tantamount to *smoking discouragement*.

Effect of Cessation Policies on Outcome

Smoking prevalence has been studied as an outcome variable as related to workplace smoking policy changes. Some authors have demonstrated a decreased smoking prevalence after imposition of controls, but other studies exhibited that smoking bans had no effect on that particular endpoint.[41] In two prospective studies by Borland, the author described a worksite *total ban*, although at one of these sites, it was acknowledged that some violations did occur. One of these papers, with a 6 month follow-up, failed to show any decrease in smoking prevalence, but in the other study with a two year follow-up, there was a modest decrease in smoking rate[42]. Hudzinski, who did not elaborate on the specifics of smoking control, showed a significant decrease in prevalence after a 12 month prohibition[43]. In 1991, a survey of three plants of similar worker population revealed that the facility with the most strict smoking control policy had a significantly

lower incidence of mean rate of smoking. However in that study there was no pre-implementation survey.[39]

More recently, workplace smoker quit rates have been evaluated. Dawley found that a comparison of two petroleum refineries revealed a higher abstinence rate in the facility which had smoking control and cessation programs, contrasted to the plant that offered cessation alone. This was after a four month follow up. The same author also found, in a four month post-intervention follow up of three chemical plants, a superior quit-rate in sites among cessation program participants in plants that offered a comprehensive approach of control and intervention, compared to control alone.[44,45]

Generally, studies quantifying the effect of workplace interventions on smoking quit rates have revealed a wide range of results. A 1990 meta-analysis by Fisher and Glasgow derived a value of 13% per year success rate.[46] In 1995 Glasgow, et al, demonstrated a much higher quit rate of 26% after two years in a study of multiple worksites, but in which program interventions resulted in no statistical difference.[47]

Smoking Control in this Study

As noted, the conventional policy has been to restrict smoking to designated areas. A more uncompromising stance is the prohibition of smoking within the building. Considering the available literature, we recognize a need

for more information regarding the impact of *strict* campus-wide workplace smoking bans. At Glaxo, a smoke-free policy was implemented in 1988, with the area of prohibition extending to the company's property line, outside as well as inside of buildings.

The purpose of this study is to expand on the data available concerning workplace smoking strategies. Although worker quit rates have been assessed, focusing on environments with varying degrees of smoking control, there has been a muddling of meanings when defining *smoking restrictions*. In fact, there appears to be a dearth of published studies considering the effect of *strict prohibition* on smoking behavior. We intend to answer whether a strict prohibition, such as has been effected at Glaxo, should have a demonstrable impact on the aggregate quit rate of that company's employees. Another outcome of interest was the amount of tobacco consumed. Moreover, most studies encompass less than a one year time interval, and we concur with other authors who argue that assessments covering one year or more should add valuable information.[48]

METHODS

Policy Implementation and Study Design

The workplace under study, Glaxo Inc., is a large European pharmaceutical company, with facilities in Research Triangle Park, N.C., and Zebulon, N.C. Three of the four campuses studied, operate as corporate headquarters, or house laboratories concerned with R&D or quality control. These campuses employ largely a professional/managerial work force, which at the time of initial survey, in 1988, numbered 1225. A forth campus (Zebulon), employing 500 mostly non-professional workers, is a manufacturing facility. In March, 1989, the company implemented a strict non-smoking policy at all of it's North Carolina facilities. In the five and one-half years since implementation, this policy has remained in force.

The policy was preceeded by a four-month lead time during which there was a facility-wide information campaign. All smoking workers were encouraged to participate in a variety of smoking cessation programs, with fees and participation time provided by the company. Smoking family members were also invited to participate. The spectrum of programs ranged from group educational sessions to

individual counseling. Among these company sponsored cessation programs were: *Quit-smart* and other audio or audio-visual programs, professional counseling, hypnosis, acupuncture, nicotine gum or patch, and the *American Cancer Society* and *American Lung Association* courses. Participation in these programs was optional.

Smokers were identified by audit of OHS clinical records, which typically contained data concerning smoking status included yearly surveillance exams. Using this population pool, a questionnaire survey was completed between December 5 and 12th, 1988, before the implementation of the program, and included the same information described in the 1994 survey (See Tables). In addition, smokers were asked at what age they initiated smoking, as well as information concerning alcohol intake, whether they engaged in regular exercise, and if family or co-workers encouraged or discouraged the smoking habit. Also it was determined if family or friends smoked. This data was merged with demographic data on file. Also in the initial survey, questions were also asked regarding the types of cessation programs wanted and the hours to be given.

From November, 1994 through January, 1995, a telephone questionnaire survey was completed. To minimize attrition, contact was attempted during the subject's work day; in some cases this required numerous phone calls. Respondents were assured of the confidentiality of the study. This survey

provided data on present status, including daily number of cigarettes consumed. Cigarette brand names were ascertained as well as type of cigarette ("light" or regular, filter or non-filter, etc.). A history of quit attempts over the past five years was also elicited; this supplied information regarding duration of each quit attempt, method used, and whether such method was company sponsored. These responses, regarding company sponsorship, were verified through company clinical records. Respondents also were asked to quantify quitting difficulty on a 1 to 4 scale, and if an attempt was unsuccessful, the respondent was asked to give an explanation for the failure. Smokers were also asked to choose from a menu of *positive* and *negative* influences on their ability to abstain. Specifically, subjects were queried: *Did the Glaxo smoking policy contribute to your decision to quit smoking?* Finally it was determined if a respondent currently used any other nicotine containing products, and each subject was asked to disclose their current body weight.

Data from the two time intervals were compared, specifically for presence of smoking habit, and for number of cigarettes consumed by active smokers. Considering several covariates, results were stratified by age, gender, race, level of income, and education. Also subgroups were identified based on number of previous quit attempts, and

level of tobacco consumption. Subgroup quit rates for the various cessation techniques were determined.

Fifty workers from the original cohort of 334 are no longer employees of Glaxo. Medical records for these subjects were obtained from the company EOHS clinics and examined for smoking status in the most recent chart entry. Smoking status at time of exit, including amount of daily tobacco consumption, was recorded for these subjects. A similar medical record audit was done on the currently employed individuals who failed to respond to the most recent questionnaire. The purpose of the medical audits was to determine if the non-participant/terminated population differed meaningfully from our respondents. These populations were compared in terms of smoking prevalence as well as in baseline demographic and behavioral variables. In an effort to further reduce a potential source of bias, an audit of exit interviews for terminated workers determined that the smoking policy was not listed as a stated reason for leaving in any of the ex-employees.

Results were compared with workplace data obtained by other researchers, with emphasis on prospective quit rates and smoker cigarette reduction.

Statistical Methods

The quit rate is defined as the number of employees having achieved and maintained cessation for at least six months divided by the number of all questionnaire respondents. The baseline disparity of demographics, previous smoking characteristics, past quitting information, health knowledge and social support, and motivation or self-belief variables between the smoking quitters and the current smokers were assessed by using an unconditional Chi-square test (or Z-test) to determine the probability that the observed association would be generated by chance, given that no difference exists between two groups. P-values were derived using a two-tailed Chi-square test for overall association, with a 95 % confidence interval being accepted as significant. The *Cumulative Incidence Ratios* (CIR) were computed as the primary measures of effects, i.e., the quit rate among exposed subjects was divided by quit rate among the non-exposed subjects (Exposure here is defined as presence of the considered variable). Ninety five percent precision-based confidence intervals (95% CI) for the relative risk were calculated according to the Taylor Series Test.

The demographic variables, and baseline smoking characteristics were compared between respondents and non-respondents by using a Chi-square test. Respondents and non-respondents in the six-year follow-up were compared for

variables in the intake questionnaire, using Chi-Square, Mantel-Haenszel Chi-Square, and Fischer's Exact tests.

RESULTS

Information obtained from the Employee Health medical records revealed from the total work force of 1725, that 1609 (93.1%) had medical documentation of smoking status, and of this number, 367 (22.8%) were identified as active smokers. Of the active smokers, 334 (91%) participated in the entry questionnaire. Status as a smoker was defined as having medical chart documentation of being a smoker, and self identification as such on the questionnaire. Current smokers were defined as those having smoked within the preceding six months, and this included the minimal tobacco consumption subset (less than 10 cigarettes a week reported) as part of the smoking cohort.

The survey completed January, 1995, included 227 respondents, or 68% of the original cohort of 334 smokers, 80% of the 284 still employed at Glaxo.

Baseline Characteristics

The demographics of this cohort were as follows (Table 1): Gender was 54% female, and only 3.6% of the total cohort was over age 50. Race was 87.5% caucasian, 9.8% black, and 2.7% other. 37.9% of respondents had no greater than a high school education, while the educational

level of 30.9% was at least that of college graduate. The occupational level of 46.4% was identified as managerial. 57% of our smoking cohort worked in the campuses that included R&D, and headquarters. 43% was employed in the Zebulon manufacturing facility. For marital status, 67% of cohort listed itself as married, 22.8% single/widowed, and 10.3% separated/divorced.

Investigating previous smoking characteristics (Table 2), we found that 46% (103/224) had begun smoking prior to the age of 17. 37.9% (85/224) of the cohort reported cigarette consumption exceeding 1.5 packs each day as their heaviest prior rate of use, but at the time of entry questionnaire only 9.5% reported this amount. During the study period, 12.9% (29/224) of the cohort attempted four or more quit attempts.

On the entry survey, we determined measures of worker health knowledge and social support (Table 3). 40.8% of the cohort reported regularly engaging in some form of exercise, but only 15.8% consumed less than one drink of alcohol per week. 62.2% of married respondents reported that their spouses encouraged them to quit, and 68.9% of those with children said their children offer encouragement. Encouragement also came from friends (56.5%), and co-workers (55.3%). Not surprising for North Carolina in 1989, we found that most of our smokers had associates who also

smoked, including family members (68.1%), friends (91.9%), and co-workers (80.5%).

As a measure of motivation and self-belief (Table 4), the entry questionnaire asked smokers *were they extremely sure they could quit?* 44.6% (25/56) who answered, did so in the affirmative, and this was later found to be a positive predictor of success.

Effects on Outcome

71.4% (N=162) of our total cohort continue to be active smokers by our definition (Table 5). Of this population, 1.3% (N=3) had not smoked within a period of one to three months, and 1.8% (N=4) had been abstinent over a three to six month period. Our successful quitter population includes 2.2% (N=5) who have been smoke-free from six months to a year, and 26.4% (N=60) who have not smoked for at least a year. Our overall five-year quit rate, defined as having currently achieved and maintained cessation for at least six months, was 28.6% (N=65).

Addressing the null hypothesis, *A non-smoking environment has no effect on the number of cigarettes consumed*, we found that there has been a significant reduction in consumption by the active smokers over the period of policy enforcement. Comparing the results of the recent questionnaire with that of the entry survey, we found that for the current smoker population, the mean number of

cigarettes smoked had been reduced from 15.7 to 12.3 per day.

Another goal of this study was to assess the effect of various cessation programs on quit rates (Table 7). We found that none of these interventions produced results that were superior to the quit rates found in the employee population that elected not to participate in such programs. On the contrary, the overall quit rate for the non-participants (N=91, 33% quit rate) was superior to that of the aggregate population that participated in any of the structured interventions (N=133, 25.6% quit rate), although the difference was not statistically significant (P=.228). Comparison of the specific programs failed to demonstrate any significant difference in quit rates. Hypnosis resulted in a success rate higher than the other interventions (N=61, 31.2%), but the finding was not statistically significant (P=.120).

A number of baseline characteristics were found to be associated with greater quitting success (Table 1). Worksite location had a significant effect on outcome. The Zebulon campus was associated with a significantly poorer outcome than the RTP location (18.6% quit rate, vs. 36.2% quit rate, P=.004). Interpretation of this finding is difficult as the two worker populations differ substantially in level of education, S.E.S., participation in smoking cessation programs, self-confidence in ability to quit, and

reported smoking habits of friends and co-workers; these differences are all significant, with P-values below 0.05.

As expected, level of education is a powerful predictor of successful abstinence (P=.036). Other demographic variables, such as gender, race, age, marital status, and occupational position had no significant effect on outcome. Not surprisingly, past smoking/quitting behavior demonstrated predictive value insofar as tobacco consumption exceeding a certain amount (Table 2). Those who stated, on entry survey, that their greatest cigarette consumption had at some point exceeded 1.5 packs per day were much less likely to conquer the habit (P=.026). Amount of cigarettes consumed failed to be a significant predictor in quantities below 1.5 packs, however. Also, if an entry survey respondent had previously been able to remain abstinent for a year or longer, the probability for smoking cessation was much greater (P=.062). Age at which started smoking had no predictive value.

Social and environmental influences apparently exert an effect on our cohort (Table 3). Quit rates were superior for employees who answered on the questionnaire that their spouses were supportive of the decision to quit (P=.042), and improved rates were also found among those whose co-workers were not active smokers (P=.042). Variables which seem to contribute little to the outcome include use of alcohol, engagement in regular exercise; encouragement from

friends, children, or from co-workers; and smoking habits of friends or family members.

The cohort was also grouped according to its survey response concerning perceived positive and negative influences (Table 6). 189 respondents answered regarding positive forces, and the most frequently listed positive factors were *health concerns* (34.4%) and *family/friends* (28.6%). However, family/friends were also mentioned as a commonly perceived negative against quitting (29.2% of 113 who responded to this question). The *Other* category was the most frequently listed option as a negative influence (48.7%), and chief among these responses were concerns about weight gain, and the impact of stress on quitting ability. Interestingly, 14 of those surveyed listed the *no-smoking policy* as the most positive influence on cessation (7.4% of those who responded to that part), but 10 respondents (8.8% of 113) considered the policy to be the single most *negative* influence on quitting. Nonetheless, one-third of all respondents stated that the smoke-free policy affected their decision to quit.

Respondents who cited health concerns (N=65) as the chief positive incentive for quitting had a cessation rate of 38.5%. Those who believed that smoking cessation classes had the greatest influence on quitting (N=4) demonstrated a 75% quit rate, while the group believing that nicotine patches were most effective (N=11) had an a poorer outcome

(9.1%). None of these findings acheived statistical significance. Respondent's perceptions of the *chief negative influence* proved to be remarkably futile as a predictor of outcome (P=.981).

Many of those who rated the policy as a negative factor also voiced their displeasure with the policy, generally complaining of the inconvenience incurred. However, during interview, the majority of respondents voiced sympathy and even support of the prohibition, and this is consistent with the prevalent perception that the policy has not become a source of poor worker morale. Finally, relative degree of self-belief and motivation were strong predictors of outcome (Table 4). Those who stated on the entry questionnaire that they were sure of their ability to cease smoking fared significantly better than their less confident counterparts (P=.045). A parallel question was introduced in the follow-up survey. Responders were asked to rate the difficulty of quitting. 42.3% (88/208) rated quitting as being *easy/not too difficult*. This response also proved to have significant predictive value. Those who answered that abstinence was *easy/not too difficult* were significantly more successful than those who perceived quitting as *moderately difficult/difficult* (P=.001).

Analysis of non-respondents

Using Chi-Square analysis, subjects lost to follow-up were compared with the rest of the cohort, based on information collected on initial questionnaire and from clinic records. Of the possible variables, respondents had a greater proportion of males and users of nicotine gum, neither of which has proven to be a significant outcome predictor in our population. Among the respondents, a proportionately larger number of employees of Zebulon were represented (P=.02). Likewise, workers whose spouses were supportive of their efforts to quit had greater representation among our responders compared to non-responders (P=.04). These two variables have shown predictive value in our study, but their potential for lending bias are mutually antithetical.

LIMITATIONS

There are some limitations to our study. The outcomes of interest, smoking cessation and number of cigarettes consumed, rely on participant response, and these answers were not independently verified (e.g., using biomarkers). However, a single biomarker measurement cannot validate sustained quitting, and is somewhat invasive. Moreover self-reports are generally considered reliable estimates of actual smoking behavior,[49] and consequently biomarkers are seldom used in these studies. Nevertheless, recall misclassification bias is possible, especially if the worker perceives a communicated demand charactistic, which may be likely considering the strong anti-smoking position taken by the company. To minimize the likelihood of such response bias, great effort was made to communicate the emphasis placed on confidentiality, and respondents were assured that all questionnaires were being identified by code numbers.

In evaluating various cessation programs, there was less reliance on recall, especially when considering company sponsored programs, as meticulous clinical records were kept following these participants as patients, and the survey responses were validated using those records. As in most

studies evaluating various structured cessation programs, self-selection bias is problematic, when comparing these subsets.

There was potential for selection bias in establishing the original cohort for the study. However, a 91% response rate was realized, and this should minimize that source of bias. We have addressed the possibility that sources of bias may have been introduced by not following up on 50 workers who have left the company, and from failure of questionnaire follow-up on 57 current employees. Indeed, if there was a suggestion that the smoking policy contributed to the decision to leave, this would certainly flaw the study. However, exit interviews provided no indication that such was the case. Moreover, employment at this company is generally considered highly desirable, and it would defy logic that the smoking policy would be a major consideration in a worker's decision to leave.

In addition, review of initial questionnaires of those lost to follow-up and comparison with participants, revealed a population difference only in two significant variables, spousal support for quitting and employment at Zebulon. The participant population may have a proportionately greater percentage of supportive spouses, and this variable may bias toward alternative hypothesis. However, there is even a relatively greater proportion of Zebulon employees in our participant group (P=.02 vs P=.04), and the Zebulon variable

has been among the most powerful predictors (P=.004 vs P=.042), so if there is any selection bias it should be toward the null.

An effort was made to establish if the lost-to-follow-up population differed in smoking prevalence from the participant group. By auditing clinical records, smoking behavior was determined for the non-participant group as well for the terminated population, considering the latter group's most recent clinical entry (usually from an exit exam). Admittedly, the prevalence data for terminated employees encompasses varying durations of time, making comparisons imprecise, but there appeared to be no significant differences between the participant population and the aggregate group of those lost to follow-up.

Finally, interpreting the significance of our results, as well as determining the external validity of the study, poses problems. There was no study control group, and making interpretations based on comparisons with outside data is difficult in light of the exceptional duration of our study. Also, even after demographic stratification, there may be reason to believe that the pharmaceutical worker, particularly the professional scientist, may have greater insights into the consequences of the smoking habit.

Our baseline population exhibited a plant-wide smoking prevalence of 22.8% documented by clinical records, at the onset of our study. This rate appears to fall within the

anticipated range, considering regional and occupational demographics for the time.[50,51] This suggests that, at least for considering it's smoking baseline, this population was not atypical.

The greatest merit of the study is the duration of follow-up. This is the first prospective study greater than five years duration, assessing the effects of strict smoking controls and various cessation methods on quit rates. This study affords the opportunity to estimate what may be the optimal quit rate that could be expected in a worker smoker population in a best case scenario. Virtually every generally known cessation method was made available to this population. Also it is the first study of it's kind to assess the impact of a smoking control so progressive and uncompromising.

Lending strength to our internal validity is the fact that our overall study population was randomly selected, drawn from clinical documents. The only potential for self-selection bias in the study occurs when we attempt to evaluated the individual sponsored cessation programs.

CONCLUSIONS

In interpreting any data relating to smoking cessation and prevalence rates, there is always a problem differentiating intervention effects from secular trends. The multiple-site COMMIT study in 1995 suggests 18.7% as a value for background community quit rate after four years.[7] Considering data from the past decade, this suggests a general trend toward improved quit rates.

As we have seen, smoking quit rates in studies focused on workplace interventions have yielded mixed results. Outcomes of workplace interventions have ranged from *no-effect*, measuring prevalence,[40] to a 13% quit-rate in a meta-analysis of studies averaging one year duration,[46] up to a 26% two year quit rate observed in the *Take Heart* prospective study by Glasgow, et al. Our 28.6% quit rate is superior to that of prior studies, although significance is difficult to interpret given the differing lengths of study period.

Our data supports the hypothesis that smoking bans decrease cigarette consumption among continued smokers. Our cohort demonstrated an average decrease of consumption of 3.4 cigarettes, a 21.7% decrease, which is significant.

This is consistent with the experience of other authors evaluating workplace bans.

Evaluation of cessation plans failed to prove the superiority of any specific program. The subgroup who underwent hypnosis had a cessation rate of 31.2, compared to 19.1 for the other programs, but this failed to reach significance (P=0.12). The overall failure of structured programs to improve outcomes in our cohort is not a new finding. In such a population, the participants are likely to differ from the non-participants in degrees of addiction, and any comparison is liable to be hindered by adverse selection.

As previously mentioned, there were several baseline characteristics that correlated with greater quitting success. As anticipated, level of education proved to be a powerful predictor of outcome among our workers. Also consistent with existing literature, heavy cigarette use was associated with low quit rates, and in our cohort those who smoked greater than 1.5 packs per day were less successful. Another logical finding was the superior quit rates among those employees who, at a previous time, had remained abstinent for a year or longer. Also predictable, was that workers who voiced self-assurance in their ability to quit, or who perceived quitting as an easy task, had very favorable outcomes.

Of some interest, was the markedly lower cessation rate at the Zebulon manufacturing facility (18.6% vs. 36.2%, P=.004). As already noted, this worker population differed significantly in the prevalence of most of the confounding variables we had identified, including S.E.S., education, self-belief, and co-worker smoking habits. Because of the multiplicity and magnitude of these differences, stratification was not practical considering the size of our N, and interpretation of this finding must be speculative. A factor for consideration, however, is the relatively rural location of the Zebulon facility. The workers at this facility are largely indigenous to North Carolina, a tobacco growing state, whose people have traditionally maintained an amicable and sympathetic attitude toward the tobacco industry.

Worthy of comment was the significant effect that co-worker's smoking had on our cohort. The *smoking co-worker* variable had an association with quit rate that equaled that of the variable, *spousal encouragement/discouragement*. Co-worker smoking status significantly exceeded *smoking family member* as a predictor, and in fact the latter variable had no effect on outcome. This co-worker influence is compatible with our argument that the general milieu of the workplace is a major determinant in employee's smoking behavior.

In summary, due to the paucity of comparable long term prospective data, it is difficult to accurately assess the efficacy of global smoking prohibition as an adjunct to an employee smoking intervention program. Our results, however, are encouraging. As in other studies which feature some form of workplace smoking control, our study supports the notion that such policies reduce the amount of tobacco consumption among continuous smokers. Also consistent with previous studies, our experience with structured cessation programs was not encouraging, although we concur with others that enormous adverse selection bias may be operative in those subsets.

COMMENT

An ideal corporate health strategy should place equal emphasis not only on the provision of a healthy, safe workplace, but also on the promotion of the elimination of risky behavioral practices among the employees. The workplace offers a unique forum to leverage the effectiveness of health promotion programs such as smoking cessation. An integrative approach, as advocated by DeJoy, and Southern, proposes an expanded role for environmental factors in the promotion and protection of worker health. This model assigns a complementary role for behavioral and environmental interventions.[32] Into this scheme, strict smoking prohibition, in conjunction with assisted cessation programs, represent an optimal work site milieu for smoking abstinence. Recognizing this, the Department of Health and Human Services has listed as one of it's *National Health and Disease Prevention Objectives*: to "increase to at least 75 percent the proportion of worksites with a formal smoking policy that prohibits or severely restricts smoking at the workplace". Reduction in smoking prevalence remains a chief public health goal, and the National Cancer Institute is using a 15% prevalence as a target for the year 2000.[24]

As cost-benefit issues become increasingly pertinent, the efficacy of a number of cessation programs have been brought to question. Hahn, et al., found that only 3% of recent quitters had participated in cessation programs during the preceding twelve months.[53] Clearly, the relative lack of worker participation presents a glaring weakness in many company sponsored programs, and community-based programs fare even worse. In the 1995 multisite study by Glasgow, the two year quit rate differed insignificantly between control sites and worksites where *Take Heart* intervention had been implemented. The authors stated that low participation may have been an explanation for the lack of results, and concluded that an aggressive workplace ban may be one of the policy changes needed for better quit rates. The same authors questioned the cost-effectiveness of intensive, highly structured (and expensive) worksite sponsored formal programs.[46] Strict facility-wide smoking prohibition, as a major adjuvant in an integrated cessation policy, is most certainly a powerful, and inexpensive tool for increasing abstinence rates.

Given the limitations of community and clinic centered anti-smoking efforts, workplace strategies represent a more efficient use of our health care dollars. Heretofore, the literature on workplace smoking cessation has emphasized intensive, and highly structured programs that have yet to demonstrate reasonable cost-efficiency. Most of these

standard interventions were made available to our study population, a number of workers elected to participate, and the results for these efforts were as disappointing as in previous studies. Considering the capacity of environmental intervention as an effector of smoking cessation, *strict smoking prohibition* represents a potentially powerful, yet under-utilized tool, toward maximizing quit rates. This study is the first to consider the outcome of such a progressive policy. In the future there should be more prospective cohort data available encompassing study periods comparable to our own. After comparison with such data, the efficacy of a global workplace smoking prohibition may be better determined.

In the meantime, although the scientific underpinnings for justification of global prohibition remain unclear, it is still reasonable for many companies to pursue more progressive anti-smoking policies. Such policies certainly present a statement about a company's philosophy, and the decision whether to pursue such policies depend to a great extent on individual corporate culture. If strict prohibition is used, it should be as a complement to a comprehensive approach integrating environmental and behavioral interventions.

Our experience suggests that a campus-wide smoking prohibition should not have a palpable negative effect on

morale. Clearly, the disadvantages of such a policy are greatly outweighed by the potential health benefits.

TABLE 1.- STUDY GROUP DEMOGRAPHICS/ QUIT RATES

Variable	N	Quit Rate(%)	P-value	C.I.R.	C.I.
Location					
RTP	127	36.2	.004	1.95	1.21-3.14
ZEBULON	97	18.6		1.00	Reference
Age (year)					
> 50	8	37.5	.569	1.33	0.53-3.33
<= 50	216	28.2		1.00	Reference
Sex					
Male	103	31.1	.445	1.00	Reference
Female	121	26.4		0.85	0.56-1.20
Race					
White	196	28.1	.498	1.03	0.50-2.11
Black	22	27.3		1.00	Reference
Other	6	50.0		1.83	0.64-5.25
Education					
<=High school	85	27.1	.036	1.00	Reference
Tech. school	31	29.0		1.09	0.57-2.08
Some college	38	18.4		0.69	0.32-1.47
College grad	50	32.0		1.20	0.70-2.04
Post college	11	72.7		2.72	1.64-4.50
Grad. degree	8	12.5		0.47	0.07-3.02
Occupation					
Manager/prof	104	30.8	.498	1.15	0.76-1.75
Others	120	26.7		1.00	Reference
Marital status					
Married	150	28.7	.372	1.65	0.65-4.16
Single/widow	51	33.3		1.92	0.73-5.06
Sep/divorced	23	17.4		1.00	Reference

TABLE 2- BASELINE CHARACTERISTICS AND QUIT RATES
Previous smoking characteristics

Variable	N	Quit Rate (%)	P-value	C.I.R	C.I.
Age when started smoking					
< 17	103	29.1	.865	1.04	0.68-1.57
>= 17	121	28.1		1.00	
Cigarettes per day					
< 1.5 pack	200	29.5	.140	2.06	0.71-6.02
>=1.5 pack	21	14.3		1.00	
Cigarettes per day @ maximum use					
< 1.5 pack	139	33.8	.026	1.69	1.04-2.74
>=1.5 pack	85	20.0		1.00	
Longest period of abstinence					
> 1 year	45	40.0	.062	1.55	1.00-2.40
<= 1 year	174	25.9		1.00	
Quit attempts since 1989					
0-3 times	195	26.7	.102	0.64	0.39-1.05
>=4 times	29	41.4		1.00	

TABLE 3.- HEALTH KNOWLEDGE AND SOCIAL SUPPORT/ QUIT RATES

Variable	N	Quit Rate (%)	P-value	CIR	C.I.
Alcohol Consumption					
>= 1/week	190	30.0	.263	1.46	0.73-2.92
< 1/week	34	20.6		1.00	
Regular Exercise ?					
YES	42	19.1	.305	0.68	0.33-1.44
NO	61	27.9		1.00	
Encouraged to quit by spouse					
YES	107	32.7	.042	1.77	1.00-3.16
NO	65	18.5		1.00	
Encouraged to quit by children					
YES	104	27.9	.563	1.19	0.65-2.18
NO	47	23.4		1.00	
Encouraged to quit by friends					
YES	105	30.5	.794	1.30	0.80-2.12
NO	81	23.5		1.00	
Encouraged to quit by coworker					
YES	105	26.7	.565	0.84	0.54-1.31
NO	85	31.8		1.00	
Family member smokes					
YES	147	25.2	.302	0.79	0.51-1.23
NO	69	31.9		1.00	
Co-worker smokes					
YES	169	25.4	.042	0.61	0.39-0.96
NO	41	41.5		1.00	
Friend smokes					
YES	194	28.4	.545	0.80	0.41-1.59
NO	17	35.3		1.00	

TABLE 4.- MOTIVATION AND SELF-BELIEF

Variable	N	Quit Rate (%)	P-value	CIR	C.I.
Extremely sure able to quit ?					
YES	25	40.0	.045	2.48	0.97-6.32
NO	31	16.1		1.00	
Difficulty to quit					
Mod. difficult/difficult	120	20.0	<.001	0.44	0.29-0.67
Easy/ not too difficult	88	45.4		1.00	

TABLE 5.- SMOKING STATUS AT GLAXO AFTER 6 YEARS OF NO-SMOKING POLICY

Smoking Status	N	% of Cohort
Smoked > 1 year ago	60	26.4
Smoked 6mo- 1yr ago	5	2.2
Total quit > 6 mo	**[65]**	**[28.6]**
Smoked 3- 6 mo. ago	4	1.8
Smoked 1- 3 mo. ago	3	1.3
Smoked within 1 mo.	155	68.3
Total smoked < 6 mo	**[162]**	**[71.4]**
Totals	227	100.0

TABLE 6.-PERCEIVED POSITIVE/NEGATIVE INFLUENCES ON QUITTING ABILITY

Variables	N	Quit Rate (%)	P-value	CIR	C.I.
Greatest positive influence					
Family/ friends	54	29.6	.268	1.00	Reference
Glaxo policy	14	28.6		0.96	0.38-2.43
Smoking cessation class	4	75.0		2.53	1.26-5.09
Nicotine gum	7	28.6		0.96	0.28-3.34
Nicotine patch	11	9.1		0.31	0.05-2.08
Health concerns	65	38.5		1.30	0.78-2.17
Other	34	29.4		0.99	0.51-1.93
Total	189				
Greatest negative influence					
Family/ friends	33	24.2	.981	1.00	Reference
Glaxo policy	10	20.0		0.82	0.21-3.27
Smoking cessation class	1	0		0	
Nicotine patch	1	0		0	
Health concerns	13	23.1		0.95	0.30-3.04
Other	55	25.4		1.05	0.49-2.23
Total	113				
Was Glaxo smokefree policy positive influence?					
YES	74	31.1	.600	1.12	0.73-1.72
NO	148	27.7		1.00	Reference
Total	222				

TABLE 7.-
PARTICIPATING STATUS OF SMOKING CESSATION PROGRAMS & QUIT RATES

Variable	N	Quit #	Quit Rate (%)	p-value	CIR	C.I.
? Program Participant						
YES	133	34	25.6	.228	0.78	0.51-1.17
NO	91	30	33.0		1.00	Reference
? Multiple Programs						
YES	32	6	18.7	.272	0.66	0.30-1.44
NO	98	28	28.6		1.00	Reference
Specific Programs:						
Acupunctr.	35	7	20.0	.420	0.74	0.35-1.56
All Others	89	24	27.0		1.00	Reference
ALA or ACA	4	0	0	.240	0	
All Others	120	31	25.8		1.00	Reference
Quit Smart	30	5	16.7	.228	0.60	0.26-1.43
All Others	98	27	27.6		1.00	Reference
Hypnosis	61	19	31.2	.120	1.64	0.87-3.07
All Others	63	12	19.1		1.00	Reference
Nicotine gum/patch	43	8	18.6	.190	0.64	0.32-1.29
All Others	89	26	29.2		1.00	Reference

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